**Problem Solving: Choose the Operation**

**What Is It?**

The process of "choosing the operation" involves deciding which mathematical operation ([addition, subtraction, multiplication, or division](http://www.teachervision.fen.com/addition/teacher-resources/34522.html)) or combination of operations will be useful in solving a [word problem](http://www.teachervision.fen.com/word-problems/teacher-resources/34516.html). For example, one way to solve the following problem is to think of it as a problem of **subtraction**, e.g.:

If there are eighteen students, and six students are not here today, how many are present?  
  
18 - 6 = ?

In comparison, the following problem can be thought of as a problem solved by **addition**.

If there are twelve students in class today and six students are absent, how many are there in all?  
  
12 + 6 = ?

**Why Is It Important?**

Choosing mathematical operations is an important part of the larger process of translating English sentences into mathematical expressions. Success depends upon two things:

(a) the ability to understand the literal meaning of the sentence

(b) the ability to express this meaning mathematically

Students who cannot understand the literal meaning of the sentence will not be able to express it mathematically, even if they have the necessary mathematical skills. (Imagine trying to solve a word problem in a language you don't know, such as Arabic.)

Even if students can understand the literal meaning of the sentence, they will not be able to solve the problem unless they can also express this meaning mathematically. In other words, successful solutions to word problems involve both reading skills and mathematical skills. In particular, choosing an operation involves, in part, identifying language clues that suggest mathematical interpretations. Consider the following examples.

If there are eighteen students, and six students are **not here** today, how many are present?

If there are twelve students in class today and six students are absent, how many are there **in all**?

The phrase "not here" conveys the concept of taking away—or subtraction. Alternatively, the phrase "in all" may signal a problem solved by addition.

Instead of teaching how to solve word problems as a separate concept, teachers should embed problems in the [mathematics](http://www.teachervision.fen.com/tv/subjects/170000000000)-content curriculum. When teachers integrate problem solving into the context of mathematical situations, students recognize the usefulness of strategies (NCTM, 2000).

Teachers must make certain that problem solving is not reserved for older students or those who have "got the basics." Young students can engage in substantive problem solving and in doing so develop basic skills, higher-order-thinking skills, and problem-solving strategies (Trafton and Hartman 1997).

**How Can You Make It Happen?**

Choosing the operation is a difficult skill for some students, especially those struggling with reading. There is no single solution. A combination of strategies will work best.

1. **Identify Key Words**

It may help to work with students to identify certain words that are commonly associated with mathematical operations. For example, the following phrases or words often suggest which operations to use. Consider displaying a table such as this in your classroom and add words and phrases as you find them in word problems.

|  |  |  |  |
| --- | --- | --- | --- |
| **Addition** | **Subtraction** | **Multiplication** | **Division** |
| in all total sum both combined altogether how many perimeter | fewer left how much change how many more how much more less difference minus remains | total in all groups area times rate twice | how many each how many groups divided equally |

It may also help to have students take turns thinking out loud as they work through word problems. For example, consider the following problem.

Juanita took twenty dollars to the mall. She bought a headband for three dollars and a bracelet for seven dollars. How much did she have left?

A student might think aloud (or write) something like this:

First I added three plus seven dollars because it said "three dollars and seven dollars" so I knew that meant to **add**. So, that was ten dollars. Then I **subtracted** ten dollars from twenty dollars because it said "How much did she have LEFT" so I knew that meant to subtract.

1. **Get to the Bottom of the Problem**

While the "key word" approach may provide hints, many problems do not provide overt clues. For example, to understand the following problem, one must understand the meaning of the words absent and present. There is no substitute for understanding the vocabulary of a word problem and what it means. This involves finding the important pieces of information, and may require students reading the problem several times, and/or students putting the problem into their own words.

1. **Draw a Picture**

[Drawing a picture](http://www.teachervision.fen.com/math/problem-solving/48931.html) or diagram is often a good intermediate step in translating a word problem into a mathematical expression. For example, consider the following word problem.

If there are eighteen students, and six students are not here today, how many are present?

This problem may be represented graphically using a picture. You could draw eighteen children in a row, then cross out six of them.

Or a table such as this:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| present | present | present | present | present | present |
| present | present | present | absent | absent | absent |
| present | present | present | absent | absent | absent |

Once presented in this way, the problem may be more easily seen as a problem of subtraction, because we are clearly "taking away" some parts from the whole. Consider having student create their own standard visual representations for problems involving[addition, subtraction, multiplication, and division](http://www.teachervision.fen.com/addition/teacher-resources/34522.html)—then have them practice choosing from among their representations given particular [word problems](http://www.teachervision.fen.com/word-problems/teacher-resources/34516.html).

1. **Unnecessary Information**

It is important to encourage students to read an entire problem before starting to solve it-deciding which information is important and which information is not needed. One method is to have them practice with problems that have too much information, such as:

Emma rode her bike the same distance as Michael. It is 12 miles from Emma's house to school, 4 miles to the library, and 1 mile to the playground. If Michael and Emma rode a total of 26 miles, how many miles did Emma ride?

Can students find 13 miles as an answer? Discuss the incorrect answer they might have found if they didn't focus on the important information. Have students create their own word problems that contain too much information, and challenge each other to solve them.

1. **Missing Information**

In some problems, information needs to be found before the problem can be solved. Sometimes students may need to find the number of feet in a yard, the number of days in the month of January, the number of minutes in an hour, or the number of ounces in a pound, before they can solve the problem. For example:

Serena buys milk every school day for lunch. How many containers of milk does she buy in a week?

I know there are 7 days in a week. There are 5 school days in a week. If she buys one container every school day, she will buy 5 containers in a week.

1. **Multiple Operations**

Some problems have multiple steps involving multiple operations. Model how to solve these problems, thinking aloud to make your thoughts visible. Have students read the problems carefully and think aloud or take notes to record their thinking. For example:

Olivia has 6 baseball cards. Owen has 2 more cards than Olivia. Oscar has twice as many cards as Owen. How many baseball cards do they have in all?

You might think aloud saying something such as:

"The problem says "how many in all," so I probably have to add. First I have to find how many cards each person has. I know Olivia has 6 cards. I'll write that down.

Olivia, 6 cards

Two more cards would be 6 + 2 = 8, so Owen has 8 cards.

Owen, 8 cards

"Twice as many" means 2 times the number. So, 8 times 2. Or I could add 8 two times. 8 + 8 = 16.

Oscar, 16 cards

Now I have to find the number of cards in all, so I'll add the cards together.

6 + 8 + 16 = 30 cards

1. **Number Sentences**

Some students may find it easier to translate word problems directly into number sentences, for example:

**Word Problem**

Katie pays with a $10.00 bill and receives $2.57 in change. How much did she spend?

**Number Sentence**

Money Katie paid with - cost of what she bought = change

Fill in the sentence with numbers and then find the missing amount to solve the number sentence.

$10.00 - cost of what she bought = $2.57  
To find how much change, I need to subtract.  
$10.00 - $2.57 = $7.43

1. **Check Your Answer**

Read the problem again to be sure the question was answered.

Katie pays with a $10.00 bill and receives $2.57 in change. How much did she spend?  
I found how much she spent, so I answered the question.

Check the math to be sure it is correct.

$10.00 - $2.57 = $7.43, and $7.43 + $2.57 = $10.00

Determine if the best strategy was chosen for this problem, or if there was a better way to solve the problem.

I used the correct information and subtracted to find the change. I chose the correct operation to find the answer.

1. **Explain the Answer**

Students should be able to explain their answer and the process they went through to solve a problem using words first, and then learn to use conventional mathematical symbols or their own forms of representations to convey their thinking. It is important for students to talk or write about their thinking. Give students frequent opportunities to explain their problem-solving strategies and solutions and to seek general methods that apply to many problems.

1. **Guided Practice**

Have students try solving the following problem, choosing the correct operation and focusing on important information.

There are 6 turkey sandwiches and 24 cans of soda. Each sandwich costs $5.85, and is cut in half. If 3 people eat 3 halves each, how many sandwiches will be left?

Have students work in pairs, groups, or individually to solve this problem. They should be able to tell or write about how they found the answer and justify their reasoning.

**How Can You Stretch This Strategy?**

Math problems can be simple, with few criteria needed to solve them, or they can be complex, requiring several steps to find the answer. As students become proficient in solving word problems, increase the difficulty of the problems you present to extend students' thinking and challenge their problem-solving skills. For example, consider these problems:

* "Manuel has fourteen books. He gets three books for his birthday. How many books does he have now?"
* "Manuel has fourteen books and loses two books, then gives away three books. How many books does he have left?"
* "Manuel is buying two books. If one book costs $14.95 and another costs $4.50, how much change will he get back if he pays with $30.00?"

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